UCID-20404

ASSESSMENT OF GAMMA 10 AND MFTF-B UTILIZATION OF TMX-U INSTRUMENTATION

G. W. Leppelmeier, S. L. Allen, T. A. Casper, and J. Osher

April 1985

Lawrence Livermore National Laboratory

Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

DISCLAIMER

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy $ Microfiche $3.50

Page Range	Domestic Price	Page Range	Domestic Price
001-025	$ 7.00	326-350	$ 26.50
026-050	8.50	351-375	28.00
051-075	10.00	376-400	29.50
076-100	11.50	401-426	31.00
101-125	13.00	427-450	32.50
126-150	14.50	451-475	34.00
151-175	16.00	476-500	35.50
176-200	17.50	501-525	37.00
201-225	19.00	526-550	38.50
226-250	20.50	551-575	40.00
251-275	22.00	576-600	41.50
276-300	23.50	601-up[1]	
301-325	25.00		

[1]Add 1.50 for each additional 25 page increment, or portion thereof from 601 pages up.

CONTENTS

ASSESSMENT OF GAMMA 10 AND MFTF-B UTILIZATION OF TMX-U INSTRUMENTATION

G. W. Leppelmeier, S. L. Allen, T. A. Casper, and J. Osher

ABSTRACT

This report examines each of the instruments now on the Tandem Mirror Experiment (TMX-U) and identifies significant tasks required to use them on either GAMMA 10 or on the Mirror Fusion Test Facility (MFTF-B).

INTRODUCTION

We have examined each of the instruments now on TMX-U and have identified the significant tasks required to use them on either GAMMA 10 or MFTF-B. The specific tasks are given in the next section of this report, on an instrument-by-instrument basis. Table 1 lists the instruments, indicates the nature of each one's control and data system, and identifies the degree of effort required, on an ascending scale of difficulty from one to four, to move diagnostic instruments from TMX-U to GAMMA 10 and MFTF-B.

There remain a number of questions to be answered, particularly in the case of GAMMA 10:

- Is the available power 60 Hz, 120 V?
- What is GAMMA 10's data processing and archiving capability? The standard TMX-U data setup is to record data in CAMAC modules, which are read after the shot, processed, and archived. Some instruments have stand-alone computers with CAMAC recording, and some have HPIB interfaces. If GAMMA 10 does not have the capability, then a data computer with CAMAC and HPIB interfaces, and appropriate utility programs, will have to be supplied in addition to the instruments.
- What support facilities are available? When TMX-U is running, we employ two electronics technicians on the day shift, one on the

Table 1. Summary of the effort required to move diagnostics instruments from TMX-U to GAMMA 10 and MFTF-B. More details are available upon request.

INSTRUMENT	DATA	GAMMA-10	MFTF-B	COMMENTS
Beam attenuation detectors	c	2	4	
Bolometers	c	2	2	
Charge-exchange analyzer	c	2	2	
CXA--time of flight	a	2	2	
Diamagnetic loops	c	4	4	
Electron cyclotron emission	c	2	3	waveguide and optics redesign
End-loss analyzers	c	2	p	
End-loss ion spectrometer	a	2	2	
EUV-22 channel	abc	1	2	
EUV-1024 normal	ab	1	2	
EUV-1024 grazing	a	2	3	d
Faraday cups	c	2	p	
Infrared camera	(other)	1	2	
Langmuir probes	c	2	3	
Microwave 140GHz	c	2	2	high maintenance
Interferometers 94GHz	c	2	2	magnetic shielding
Microwave scattering 140GHz	c	2	2	uses interferometer signals
94GHz	--	--	--	not available
Net current collectors	c	4	p	
Neutron detectors	c	1	2	
Plasma potential diagnostic	a	3	p	

Table 1. (Continued.)

INSTRUMENT	DATA	GAMMA-10	MFTF-B	COMMENTS
RF probes	a	4	p	electronics useful
RGA	c	2	3	
Secondary emission detectors	c	2	4	
Thomson scattering	c	3	4	
Vacuum gauges	c	2	3	
Video camera	(other)	1	2	
X rays	a	2	2	

Explanation of table entries

- a Stand alone with CAMAC. A separate computer system--typically an HP desktop is used for control, acquisition, processing and archiving, but a parallel CAMAC path could be used.
- b Stand alone without CAMAC. Like the above, but without the possibility of a parallel CAMAC interface.
- c TMX-U's standard CAMAC module acquisition, with postshot readout, processing and archiving by a central computer system.
- d Smaller, more convenient units are now available commercially.
- 1 Less than 2-FTE-months effort.
- 2 More than 2-FTE-months effort, but less than 6.
- 3 More than 6-FTE-months effort.
- 4 The effort to move existing equipment probably exceeds the effort to build replacements.
- p The measurement concept does not apply.
- FTE Full-time equivalent employee.

evening shift and we require an as yet undetermined amount of shop effort to maintain diagnostics instrumentation. The level of support effort varies: spectrometers, in general, require very little technician support, whereas Thomson scattering, plasma potential diagnostics, and interferometers require a good deal of support. On average, on-the-floor maintenance requires 0.1 to 0.2 full-time equivalent employee per instrument.

- Is GAMMA 10's grounding and shielding practice the same as TMX-U's? If not, the cabling and signal connections will have to be redesigned. Note that some instruments have restrictive limits on allowable cable lengths, whereas others require that special cables be made.
- Is GAMMA 10's timing system compatible with TMX-U's? Specifically, are timing signals and clock protocol usable? If not, timing units would have to be designed and fabricated.

EFFORTS REQUIRED TO MOVE INSTRUMENTS

Beam Attenuation Detectors (BAD on TMX-U, NBA on MFTF-B. Three arrays available on TMX-U).

Mechanical

GAMMA 10--The detectors are in the form of an integrated array. Redesign and fabrication of the support structure are required.

MFTF-B--The much higher heat loads and longer pulses on MFTF-B require a redesign of the detectors themselves.

Electrical

Other than recabling, there would be no significant work required.

Data recording

Data acquisition is in CAMAC modules; processing and archiving must be supplied.

Interference

Digital electronics would have to be duplicated.

Bolometers

Mechanical

The sensor units are small, and could be easily mounted in a variety of locations. They are also currently mounted on movable probes in some locations.

Instrument Electronics

A separate control unit can operate 22 sensors. This unit can be remotely controlled by a computer. It provides a -5 to +5 volt signal for each channel.

Data recording

Any system capable of recording the voltages is suitable; currently Lecroy digitizers in a CAMAC crate are being used.

Interference

There is only one control unit for the sensors.

Charge-Exchange Analyzers [CXA--two units, a standard swept-voltage 90-degree parallel-plate analyzer and a time-of-flight (TOF) instrument].

Mechanical

GAMMA 10--The standard TMX-U CXA instrument is fairly massive with its magnetic shielding, but it is designed as a portable unit for external port mounting. The TOF instrument is fairly light except for its associated small turbomolecular pump/chopper, and is easy to move.

MFTF-B--Both units are of possible use for MFTF-B, probably with increased magnetic shielding needed. The energy range of the TOF instrument (20 eV to 5 keV) is rather low, so its use on MFTF-B is uncertain and would require a major correction for low energy flux attenuation by the intervening plasma. The energy range of the standard CXA instrument is approximately 1 keV to 20 keV. This too is rather low but can likey can be increased somewhat with minor changes.

Instrument Electronics

The swept high voltage power supply for the 90-degree analyzer, the high voltage power supply for the TOF instrument, the speed controller for the chopper/pump, and associated I/V amplifiers are all standard, but they are also easy to move and should be considered as part of a complete unit. Both CXA instruments use turbomolecular pump units for separate vacuum pumping.

Data recording

Data acquisition is done with standard CAMAC, although special data processing is required to unfold the sweep voltage/analyzer calibration, or the TOF timing from the chopper reference. At present a stand-alone computer system is planned for the new TOF instrument under construction. A standard computer is needed for processing and archiving data for the standard CXA instrument.

Interference

Only the two instruments are available. The energy range of the TOF instrument is more suited to GAMMA 10 physics parameters. The electronics of each unit should be included in any move.

Note on mechanical size

The standard CXA instrument is ∿6ft x 2ft x 1ft and weighs about 1,000 lb, including the turbomolecular pump needed for the associated vacuum system. The associated electronics can be fitted into a single rack. The TOF instrument consists of three main pieces--a small special turbomolecular pump/chopper, a 2-to-5-m TOF tube, and the high-gain detector head. The total weight of the TOF instrument is <500 lb, including a single rack for electronics.

Diamagnetic Loops (9 sensors) GAMMA 10 and MFTF-B

Mechanical

The loop sensor is easily constructed and critically dependent upon the physical dimensions of the plasma to be diagnosed. Since significant modifications are required, it appears that the cost of transporting it would equal or exceed the cost of reconstruction for a given experiment.

Instrumental electronics

Only transportable anti-aliasing filters are used.

Data recording

Standard TMX-U CAMAC recorders are used with the diamagnetic loops and these are transportable. Acquisition software would be required to integrate these recorders into the available computer system. Processing of the loop information is trivial except for noise reduction. Due to the dc fields on MFTF-B, this is not an issue. If noise problems are present in the GAMMA 10 environment, the various software-processing concepts used on TMX-U could be applied to GAMMA 10; but note, however, that noise suppression would require time and effort to realize.

Electron Cyclotron Emission (3 swept- and 2 fixed-frequency receivers)

Mechanical

GAMMA 10 and MFTF-B--All waveguide runs, internal and external to the vacuum tank, are specific to the experiment in question; they would have to be custom designed for the measurement location. To make an unambiguous measurement, the appropriate focusing optics and viewing dump would have to be designed specifically for the measurement location for the experiment considered. Thus, only a minimal amount of hardware is directly transportable, except for microwave components from which a custom system could be constructed.

Instrumental electronics

Receivers available include the following:

swept 8-12GHz owned by Univ. of Maryland,
swept 12-18GHz owned by Univ. of Maryland,
swept 26-40GHz owned by Univ. of Maryland,
fixed at 60GHz owned by LLNL,
fixed at 94GHz owned by LLNL.

GAMMA 10--Since the field strengths and electron temperatures are comparable in TMX-U and GAMMA 10, the existing swept- and fixed-frequency heterodyne receivers would be directly applicable for measurements in GAMMA 10 and could, therefore, be transported with a minimum of difficulty.

MFTF-B--The actual swept- and fixed-frequency heterodyne receivers are transportable but would require some modifications to fit in the remotely controlled environment of MFTF-B. Since the field strengths and electron temperatures in MFTF-B tend to be higher than in TMX-U, the only location where existing receivers would find application (without a more detailed study) is in the central cell. Higher frequency, quasi-optical techniques are required in the barrier regions. These types of receivers have not yet been used on TMX-U.

Data recording

GAMMA 10 and MFTF-B--Only standard TMX-U data recorders are used and the application of these to either experiment requires the acquisition and data-processing software for the system computer.

Interference

The receivers are modular and can be distributed between the experiments as desired. The University of Maryland owns the three swept-frequency receivers.

End-Loss Analyzers (ELA. Five units)

Mechanical

GAMMA 10--Design and fabrication of new support structures or mounting on end-dome ports would be required.

MFTF-B--The concept is not applicable.

Electrical

The technical concept limits the ELA's to about 3, at most 5 keV. Thus, it is applicable for GAMMA-10, but not MFTF-B.

Data recording

Data are taken by CAMAC recorders. Thus, a computer with CAMAC interface, and processing and archiving facilities would be required.

Interference

None.

End-Loss Ion Spectrometer (ELIS. One complete, a second in assembly)

Mechanical

GAMMA 10--The instrument itself would be well adapted. However, it is bulky (∿1000lb) and consequently port adapters and the support structure for mounting on an end wall would require a fair amount of engineering.

MFTF-B--The range of the instrument does cover energies appropriate to MFTF-B operation. The instrument is physically larger than the instrument designed by TRW for MFTF-B by a factor of two, so that mounting, scaffolding, and shielding all require more effort.

Instrument electronics

There are two rack's worth of electronics, which would be a lot to ship. As concerns application on MFTF, it is not known now if the power supplies and amplifiers would support the much longer cables required were the electronics located outside the vault.

Data recording

Data recording is in CAMAC recorders, with a stand-alone, desk-top computer for control, processing, and archiving.

Interference

The cumbersome size and weight of the instrument and electronics would cause delays in moving from one location to another.

EUV-22 Channel (LLNL owns)

Mechanical

This instrument is designed to be portable. Shipping boxes exist. An f/11 field of view is required. Connection is to a 4.5-in. Conflat flange. A vacuum beamline (no window) would be necessary.

Instrument electronics

Stand-alone instrument electronics exist; cables would have to be provided. Control is by separate control units; these are not computer controlled.

MFTF-B

Separate control units might have to be computerized.

Data recording

Data recording is by stand-alone HP9836 or an equivalent computer system. Data recording can be done by CAMAC dual port memory, which is read by the computer.

Interference

There is only one instrument; it would have to be either at GAMMA 10 or MFTF-B.

EUV-Normal Incidence 1024 Channel (Johns Hopkins University owns)

Mechanical

This instrument is designed to be portable. Shipping boxes exist. Connection is to a 4.5-in. Conflat flange. A vacuum beamline (no window) is required.

Instrument electronics

Stand-alone instrument electronics exist; cables would have to be provided. Detector control is by a HP9836 computer.

MFTF-B

All attributes would be basically the same, except that the instrument electronics would have to be computer controlled by the MFTF-B environment (either use the HP9836 or an interface).

Data recording

Data recording is by stand-alone HP9836 or an equivalent system. Data recording can be done by CAMAC dual port memory, which is read by the computer.

Interference

There is only one instrument.

EUV-1024 Channel Grazing Incidence Spectrograph (E-Division owns)

Mechanical

This instrument is not specifically designed to be portable. It is a heavy (about 1,000 pounds) instrument that is approximately 6ft x 4ft x 3ft. As currently designed, it must be oriented so that it views the plasma horizontally.

Instrument electronics

The system has a stand-alone control system that consists of an instrument rack located near the spectrograph and a control rack in the diagnostic area. This allows remote control of the pumping system (turbomolecular).

Data recording

A PDP-11 is used for recording of data.

Interference

There is only one instrument.

Faraday Cup Detectors (FC. Four interior arrays of 6 detectors each, 12 individual detectors, and 2 movable detectors on probes)

Mechanical

GAMMA 10--The TMX-U FCs are installed on the interior end walls, behind gridded openings in the potential control plates (PCP). Removal would be fairly straightforward, but reinstallation would require coordination for access, custom installation of the detectors with any end plate potential control structure, and appropriate interior and exterior cabling. The separate probe units are easier to adapt to GAMMA 10 providing there is sufficient port access for the probe heads.

MFTF-B--The TMX-U FCs would generally not be adaptable to MFTF-B use without a redesign for increased cooling. The electron control grid voltages are impractical for this design.

Instrument electronics

The electron suppressor grid bias supplies and the I/V amplifiers are standard and relatively easy to move.

Data recording

Data acquisition is with CAMAC modules and a standard computer is needed for data processing and archiving.

Interference

No instrument interference is likely due to FC not being suitable to MFTF-B application without redesign. Electronics are modular and could be used with either machine or split between the two.

Note on mechanical size

Each FC is a few cm in diameter and ∿10 cm long. The arrays are ∿10 cm x 10 cm x 60 cm. The probes are ∿230 cm long. The electronics would require a double rack (including position controls on the movable FC).

Infrared Camera System

Mechanical

The system is modular and set up so that the camera is a remote system. A standard tripod mount is used to mount the camera. A special window is required to view the plasma.

Instrument electronics

The readout system is separate from the camera system. Cables would have to be run to the camera.

Data recording

Currently, a high quality video tape recorder is being used for data recording. The digital analysis can be done to some extent with a digitizer attachment to the camera. More sophisticated analysis requires a separate system.

Interference

There is only one instrument.

Langmuir Probes (6 units)

Mechanical

GAMMA 10--Generally these are movable, and therefore the design of mounting hardware is specific to the installation and fabrication is relatively expensive. The probes themselves would be usable.

MFTF-B--The higher heat load makes a complete redesign necessary.

Electrical

There is no problem for GAMMA 10; power supplies may have inappropriate voltage/current capability for MFTF-B.

Data recording

Data acquisition is in CAMAC modules. Processing and archiving must be provided.

Other considerations

None.

Interference

CAMAC equipment.

Microwave Interferometers (4 channels at 140 GHz and 8 channels at 94 GHz)

Mechanical

GAMMA 10 and MFTF-B--All waveguide runs, both internal and external to the vacuum tank, are specific to the given experiment. Therefore it would not be reasonable to transport any of this equipment directly. Microwave components (sections of waveguide, bends, etc.) could be used for custom installation.

Instrumental electronics

a. 140 GHz; GAMMA 10 and MFTF-B--While the electronics hardware is directly usable, the EIO tube and its power supply have proved to be operator intensive to maintain. A skilled electronics technician has been required to maintain this system on TMX-U.

b1. 94 GHz; GAMMA 10--The electronics consist of self-contained units with solid state transmitter and receiver components located in a single, magnetically-shielded enclosure that is placed locally at the measurement location at the vacuum tank. These units could be transported to the GAMMA 10 experiment and hooked up to wave guides that would have to be added internally to the GAMMA 10 machine. Mechanical support of the receiver units would be required. Depending on the ambient field strength at the vacuum vessel, some additional magnetic shielding of the transmit/receive units may be required. No external waveguide runs are required, however.

b2. 94 GHz; MFTF-B--The transmit/receive units described above would also be directly transportable to MFTF-B with the addition of some extra magnetic and neutron shielding. The electronics must be configured to allow the remote control of the receiver (i.e., turn on, turn off, and reset).

c. Digital phase detectors for both the 140- and 94-GHz systems are similar. These would be directly usable on either experiment with the exception that some modification might be required for operation in the remote control environment of MFTF-B.

Data recording

GAMMA 10 and MFTF-B--All data recorders are standard TMX-U CAMAC units. They could be directly useable but would have to be integrated into the timing and control system. Additional acquisition software would be required to store the data in the system archive; i.e., SCDS or GAMMA 10.

Interference

The four channels of 140-GHz interferometry are derived from a common high power source and must move together. The 94-GHz units are modular and can be distributed between the experiments as desired.

Microwave Fluctuation Diagnostic (forward scattering) GAMMA 10 and MFTF-B

Mechanical

Same as interferometers.

Instrumental electronics

The microwave density fluctuation diagnostic is derived from the first IF stage of the 140-GHz-interferometer electronics. Added electronics are used to amplify, filter, and mix the signals to baseband. This equipment is transportable in the same sense used in the discussion of interferometers.

Note that no density fluctuation diagnostic is available for the 94-GHz system, and the 140-GHz system has required a fair amount of electronic technician support for maintenance.

Data recording

Same as interferometers.

Interference

Same as the 140-GHz interferometer system.

Net Current Collector (several insulated plates each end)

Mechanical

GAMMA 10--The TMX-U array of small current collector plates is internally mounted on each end behind gridded openings in the potential control plates. These simple plates are easily movable, but would require internal access, custom mounting, and appropriate cabling.

MFTF-B--The plates are unsuitable for the MFTF-B heat load.

Instrument electronics

The needed I/V amplifiers are standard and easily movable.

Data recording

Data acquisition is with CAMAC modules and a standard computer is needed for processing and archiving.

Interference

There is no instrument interference, as the plates are unsuitable for MFTF-B use. Electronics are modular so they could be used with either machine or split between the two machines.

Note on mechanical size

The plates weigh only a few pounds and the electronics would fit into a single electronics rack.

Neutron Detectors (NCT. Two units)

Mechanical

GAMMA 10--These detectors are quite flexible as to where and how they may be placed. Some redesign of mounts would be necessary.

MFTF-B--Shielding calculations would be required, with new shielding certainly required.

Electrical

There are no problems other than recabling.

Data recording

Data acquisition is in CAMAC modules. Processing and archiving would have to be provided.

Interference

There is no interference other than the simultaneity problem. This is probably one of the easiest diagnostics to move.

Plasma Potential Diagnostic (PPD. One unit, with spare ion source)

Mechanical

GAMMA 10--Redesign and fabrication of the mounting and support structures for the source, the primary beam detector, and the secondary beam detector would be required.

MFTF-B--The physical size and magnetic field are so much larger that none of the hardware would be usable.

Electrical

Depending on the specific geometry and field of GAMMA 10, a higher voltage source may be required. Integration to timing system is required.

Data recording

PPD is currently running stand-alone with a HP desktop for control and data acquisition, processing, and analysis. A CAMAC interface to GAMMA 10's data system would permit inclusion of its data in the GAMMA 10 database.

Other considerations

If the field and geometry are much different from those of TMX-U, a complete recalculation of orbits will be required before design of component locations could begin.

Interference

None.

RF (radio frequency) Probes (5 arrays; 24 high speed and 52 standard channels)

Mechanical

GAMMA 10--The sensor design is compatible with the GAMMA 10 experiment. The probe size, support, and transport mechanism would need a significant amount of redesign to fit the GAMMA 10 vacuum vessel. Since the sensors are simple, the cost to modify them for the GAMMA 10 experiment and move them is comparable to the cost to build them.

MFTF-B--The design of the sensors is not compatible with the severe heat flux expected in the MFTF-B device and thus the TMX-U rf probes are not transportable. Similarly, the large difference in size of the vacuum vessels makes it impossible to use the support and probe transport mechanisms.

Instrumental electronics

GAMMA 10--All amplifier chassis, filters, and envelope detector chassis would be directly usable on the GAMMA 10 experiment since the field strengths and operating conditions are similar.

MFTF-B--All amplifier chassis would be usable. Because the magnetic field is greater in MFTF-B than in TMX-U, the ion-cyclotron frequency is higher and this implies that some filter and envelope detector chassis may need to be modified. Some repackaging would also be required to meet the computer-readability requirement necessitated by the remote control and acquisition system on MFTF-B.

Data recording

GAMMA 10 and MFTF-B: The transient recorders, both slow and fast, are CAMAC units and therefore would be directly usable on the other experiments. A fair amount of processing software may need to be developed, depending upon the availability of similar routines on the system computer.

Interference

The electronics are modular and can be distributed in any proportion between the experiments.

Residual Gas Analyzers (RGA)

Mechanical

The sensor units are portable, and are installed on a standard flange. They would require magnetic shielding.

Instrument electronics

The control electronics consist of a separate control unit that is located up to 200 feet away from the readout head. Remote control of this unit by computer is possible, but not currently used.

Data recording

The output is a 0-to-10-volt signal that could be digitized by any appropriate unit. The current electronics are Lecroy units in a CAMAC crate.

MFTF-B

The four TMX-U units are the same brand and model as the 11 units that have already been purchased for MFTF-B. As such, they could supplement these units if more were needed.

Interferences

The units could be split between GAMMA 10 and MFTF-B.

Secondary Emission Detectors (SED. Two interior arrays, and two probe arrays)

Mechanical

GAMMA 10--The two TMX-U interior arrays consist of 9 detectors each, viewing the sloshing ion regions at 5 degree intervals up to 90 degrees. These arrays can be fairly easily removed from TMX-U, but reinstallation in GAMMA 10 would require coordination for open access, custom interior mounting, and appropriate internal and external cabling. In addition, the TMX-U set of SED includes a probe with a small array of five detectors (used to radially scan from -15 cm to + 30 cm), and a second probe with three detectors including a wide angle unit. The probe units, or disassembled interior array units, could be moved and easily remounted if appropriately located ports or fields of view were available.

MFTF-B--The TMX-U SED interior arrays or probes are inappropriate for the scale and heat loads expected in MFTF-B 0.5-s or 30-s operation. The individual SED units from disassembled arrays might be considered for use in a new, well-cooled, small collimation design.

Instrument electronics

The secondary-electron-emitting electrode bias supply, and the needed I/V amplifiers are standard and would be easy to move.

Data recording

Data acquisition is with CAMAC modules and standard computer support is needed for processing and archiving.

Interference

There is no instrument interference, as the instruments are not directly usable on MFTF-B. The electronics are modular, so they could be used on either machine or split up.

Note on mechanical size

The interior arrays are each approximately 5 cm wide, by 25 cm high, and 100 cm long (arc). Each of the probe heads require a minimum port clearance of about 15 cm. The total weight is estimated to be several hundred pounds plus a similar weight of electronics (filling a single electronics rack).

Thomson Scattering System (TSS. Two independent systems, with multiple radial position capability)

Mechanical

GAMMA 10--At a minimum, a new support structure and port mounts would be required for the laser and receiver, and for beam dumps. Depending on specifics of the GAMMA 10 vessel, new lenses would possibly be required. Careful redesign of the optical paths would be required. Disassembly in Livermore and reassembly at Tsukuba could take a significant time (a minimum of 2 to 3 months).

MFTF-B--Because of the much larger size of MFTF-B the lasers and optics simply aren't usable, but the spectrometers are.

Electrical

Power supplies and internal controls are no problem. Integration to the machine timing system would be required.

Data recording

Data acquisition is in CAMAC modules. Processing and archiving must be supplied.

Interference

The control and data acquisition electronics, the spectrometers, and the photomultiplier tube assemblies cannot be in two places at the same time.

Vacuum Gauges

Mechanical

The gauge units are either Bayard-Alpert (BA) or Magnetron. They are standard flanges which could be mounted at the vacuum wall or inside the machine. The BA gauges need magnetic shielding.

Instrument electronics

The gauges use separate controllers that are installed near the gauges; these should not be a problem.

Data recording

The electronics are all standard Lecroy modules.

MFTF-B

The gauge systems have been designed so that they can be directly transferred to MFTF-B if necessary.

Interference

The gauges and Lecroy electronics could be split between GAMMA 10 and MFTF-B.

Video Camera System

Mechanical

The system is modular. The camera unit is small, and requires a tripod mount. There is a cable limitation of 150 feet from the camera to the controller unit. The complete system can be shipped in cases that LLNL owns.

Instrument electronics

Stand-alone control by control unit.

Data recording

An integral high-speed tape drive stores the data; a video display is included. A digital output is available (IEEE standard); this can also be used to control the camera.

Interference

There is only one instrument.

X-ray Detectors (Six detectors and a pin-hole camera)

Mechanical

GAMMA 10--Each of the six detectors [three NaI, two Ge, and one Si(Li)] is by itself relatively small and portable. The bulk of each instrument is the Pb x-ray collimation and shielding and the extensive neutron shielding. Each instrument can be moved subject to provision for needed fields of view and available space at external access ports. For softer x rays a special low Z thin window is required and a far side "viewing dump" is desirable.

MFTF-B--Each of the above x-ray packages can be moved and used on MFTF-B, with only minor increases in neutron shielding. Access requirements are already planned as part of the MFTF-B x-ray detector system (XRS).

Instrument electronics

The low input capacitance, low noise, high-gain amplifiers and pulse height analyzers should be considered part of the package if moved. The high voltage power supplies are standard. The x-ray camera electronics is special and should be moved with that unit.

Data recording

Data acquisition is with CAMAC with a stand-alone HP9836 computer system.

Interference

Each of the six detectors or the x-ray camera can be used with either machine or split up as appropriate. However, if split up, each machine would need a stand-alone HP9000 computer system.

Note on mechanical size

Each of the above detectors weighs approximately 30 lb, however, the present shielding for each would include approximately 1800 lb of lead and 1600 lb. of neutron shielding. The x-ray camera weighs 135 lb, but also uses 3100 lb of lead, and 1100 lb of neutron shielding. The associated HP 9000 computer system and five single widths of rack space weigh over 1000 lb.

MFEPC/85-109
3951w/0483t/kt